WHEAT PRODUCTIVITY AND PLOUGH LAND INEQUALITY IN RURAL CROATIA

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Abstract:

The unequal distribution of plough land could be according to a prior naive theorizing be a source of inefficiency in wheat production. The paper investigates whether, plough land inequality due to specific less or more egalitarian land distribution, and is a source of possible inefficiency measured by wheat productivity within Croatia's counties. We analyze these issues by using cross-county data on inequality in operational holdings of plough land from Agricultural Survey in 2003. After constructing the Gini coefficient for plough land holdings, and other relevant exogenous variable which cover necessary inputs condition as a average holding size per ha, labor, capital (represented by alternative variables summed by number of combine harvester and tractor), among counties, an estimation of an production function, is done by OLS estimations of wheat output.

JEL classification: Q11, Q16

Keywords: Wheat Productivity, Production Function, Plough Land Inequality, Croatia

Introduction

This paper examines the relationship of plough land distribution and wheat productivity across counties in Croatia by utilizing data on the distribution of operational family farm size within counties calculated by the Agricultural Survey (2003). As a prelude in a core of the problem, consider figure 1 which plots wheat output per hectare against plough land inequality as measured by the Gini coefficient. There is a significant negative relationship, showing that inequality in plough land size within a country is associated with low wheat productivity, or alternatively whit a low operational holding size (see Figure 2).

The robustness of previous scatter relationships is addressed by including the Gini coefficient in the estimation of a wheat production function. The results show that the negative relationship between plough land inequality and what productivity persists even in half-intensive production function for wheat when controlling for input use, as a family farm size, aggregated capital, and labor.

The negative relationship between overall land distribution and agricultural productivity is consistent with the productivity advantages of farms operated primarily with family labor, something documented by several lines of research. A bunch of papers (Johnston & Kilby 1975, Johnston & Clark 1982, Tomich, Kilby & Johnston 1995) examine the variability between unimodal (or equitable) and bimodal (or unequal) agrarian structures among countries. They stress that for most countries the equalitarian land allocation structure among family agents is more productive because it equalizes the marginal product of labor across farms. Labor misallocations arise in unequal land in use structures because labor supervision costs and policy distortions combine to make capital relatively cheap for large farms. This article is leaning on (Vollrath, D., 2007) and his very robust exposition, model construction and econometric methodology. In this paper we should concentrate on testing the excepted negative trade-off between wheat productivity and plough land inequality having only wheat production along various Croatia's counties in mind.

The aim of the paper is to analyze quantitatively production characteristics of the wheat output per hectare based on Cobb-Douglas production function augmented by Gini coefficient and family farm holding size. Obtained elasticity's results are estimated by OLS estimation. The collaterally results as a technical progress in the wheat production is deduct and we discuss their consequences at the end of the paper.

Data source

This paper has quantified the effect of plough land distribution on cross-county wheat productivity by using data from the website (http://www.dzs.hr/hrv/censuses/Agriculture2003/census_agr.htm) (2003) regarding the Gini coefficient for the size of operational land in use holdings within counties.

Measuring Plough Land Distribution

The distribution of plough land among family holdings is measured using data from Agricultural Survey (2003). We computed Gini coefficients for the size distribution of plough land within 22 Croatia's counties using data about plough land size in ha weighted by distinctive cohort variability (from less than 1.5 ha to the more than 20 ha) . The size classes used are standard across counties, observed in 2003, so that the Gini is comparable across counties. The Gini coefficient in mean is about 0.27, very distinctly measures the average distribution of plough land among family holdings. Because it's nearer to bottom limit than the upper (theoretically the Gini could be in 0-1 interval) we note convergence toward unimodal distribution of plough land and presence larger concentration area on medium range in ha land plots. In Krapinsko – zagorska County County we noticed maximum Gini (0.5) as extreme in and in Grad Zagreb only 0.12 but nevertheless the first figure we should stress relatively egalitarian structure of plough land distribution. Very plausible it is inheritance of agricultural reform after the Second World War and interdiction of land property above 15 ha *per capita.* Now we hypothesize, could the low median value (0.24) for Croatia's counties suggest that low plough land inequality does lead to high wheat productivity. One limit of the (low) Gini coefficient is that it cannot distinguish between a very few extremely big plough land family holdings or numerous small family plough land possession, or shortly it can not properly shed a light among differences in the scale of plough land across counties, But from visual inspection of the data we find that medium range in ha land is overrepresented. However, to address this additional control for average family farm per size (land in use in ha) is construct. Average family holding size per land in use ranges from a high of 4.18 hectares in Bjelovarsko – Bilogorska in 2003 to a low of 1.23 hectares in Splitsko-dalmatinska County in same year. The median land in use size per rural family in the Croatia falls only to 2.75 hectares *per* our calculation in 2003, yet averaged 2.9 ha in 1998 or 6 ha about a century ago according to history review (Mihalj, P, p. 1 ¸ 1998), those figures gives a six fold difference in holding size between the very developed OECD countries (although measured in 1980) and the Croatia's regions. The broad historical and institutional factors with its deep impacts on land inequality and distribution in Slavonia region has been analyzed, thereby we refer to an excellent study (Bosendorf, J., 1950). A plot of the Gini coefficient and the log of average holding size are shown in Figure 2. There is a small (if the farm size increase on average 1 ha the Gini will fall about 0.05 indicate slightly more unimodal structure, and statistically insignificant negative relationship between the two measures. Both measures will be included in each specification to capture both aspects of land distribution.

Plough Land Distribution and Wheat Productivity

Overall wheat output per hectare in the economy, y, is simply a weighted average of the wheat output per hectare of each farm type within each county. Otherwise, y is measure for land plot productivity. If we distinguish between small (θ_s) and large (θ_l) plough land endowment (expressed in average land area) in wheat production and if we conceive for a moment that one portion of all family plough land holdings are small farms and attach $1 - \lambda$ in front that batch, and as a opposite λ stands for large farms, we can specify the following equation for wheat output productivity per ha

(1) $$y = A\,[(1 - \lambda)\,\theta_s f_s(x_s) + \lambda\theta_l f_l(x_l)]$$

The term λ in previous specification is thus a crude proxy for the Gini coefficient of land inequality, A is total factor productivity (TFP), and the terms $f_s(x_s)$ and $f_l(x_l)$ are the per-hectare production functions applicable to small and large farms, respectively, and x_i, $i = s, l$ is the vector of per-hectare inputs used by each type of farm. If there is no difference in production between the types of farms, then $f_s(x_s) = f_l(x_l)$ and the expression for wheat output per hectare in (1) reduces to

(2) $$y = A\,[(1 - \lambda)\,\theta_s + \lambda\theta_l]\,f(x)$$

where $f(\cdot)$ is the general production function common to both kinds of farms and x is the vector of aggregate input use per hectare. The term in brackets in equation (2) is simply average family holding size in a county.

In estimating the effect that the distribution of operational holdings has on wheat productivity, a basic assumption will be that all counties share a common production function because of law of one price in a small economy as a Croatia is. Due those assumptions the inputs and output wheat price tend to equalize and converge to one steady value for each county, respectively in given point of time. This assumption is common to the literature on cross-county (or even country which is less plausible because of possibility of different efficiency labor or capital units required per ha unit of wheat production) agricultural productivity. The specification used for estimation follows this literature as well and can be written in its most general form as

(3) $$\ln Y_i = \beta_0 + \beta_1 G_i + \beta_2 \ln Z_i + \beta_X \ln X_i + e_i$$

where Y_i is wheat output per hectare , G_i is the Gini coefficient, l_i is land per holding, X_i is a vector of inputs in per hectare terms, and e_i is a potentially heteroskedastic error term. The coefficients β_1 and β_2 capture the partial wheat productivity effect of plough land inequality and average family holding size, respectively. βX is vector of input coefficients for their respective of control variables, and β_0 is a constant. Including total land in X_i would allow for the possibility of decreasing or increasing returns. Excluding total land from X_i implicitly assumes the production function is constant returns to scale, if we introduce some restrictions. It is the best that in that context simultaiasly we obtain the TFP contribution to wheat output production among counties. To gauge out partial wheat productivity effect of TFP which could be different among counties we should neglect for a moment previous general to specific strategy (in which we dropped out "statistically insignificant" variable), and focus on intensive form of Cobb-Douglas production function given in per person –worker type due to constant return to scale restriction of following type,

$$\ln \dot{y}_i = \ln \alpha + \ln \beta_x \dot{k}_i \,, \qquad (4)$$

In (4) $\ln \dot{y}_i$ as a wheat output per ha divided by number of employees on farm (conditioned by workers who are indexed by higher than six hours pro day working) stands for ln Y – ln R (R is number of employment), and $\dot{k}_i$ is aggregate capital inputs measured by number of combine harvester and tractors divided by same labor weight. In a competitive equilibrium, βx is the fraction of wheat income after reselling by unique wholesale price that goes to the capital input, and 1- βx is the fraction that goes to the labor input thus does fulfills condition of the constant returns to scale (1- βx + βx =1).

The evolution of the wheat output per ha/labor ratio is determined by movements in the capital/labor ratio and by technical progress (incorporated by Solow residual after regression is obtained). Put differently, the Solow residual as a measure of total factor productivity is according to (5),

$$\widehat{A} = \frac{\widehat{Y}}{\widehat{L}^{(1-\beta x)}\,\widehat{K}^{\beta x}} \,. \qquad (5)$$

If we determinate (5) that the TFP is dependent on the Gini and family holding size too than the TFP should in half-intensive form be calculated as a

$$\widehat{A} = \frac{\widehat{Y}}{e^{\hat{G}\beta 1}\,\hat{Z}^{\beta 2}\,\widehat{L}^{1-\beta x}\,\widehat{K}^{\beta x}} \,, \qquad (6)$$

Because the Gini indicators is given in linear form and in log-lin specification the elasticity's of regression is equal to slope which stands before the variable we involved e=2.718282 as a base below the Gini and its elasticity, the other exogenous variables are given in log form and elasticity are present as a exponents.

Ordinary Least Squares Specifications and Results

The base estimations pool the 21 observations together and uses ordinary least squares (OLS), to estimate specifications of the form found in (3) in various form is given in Table 1. The initial specification in column (1) includes only the Gini coefficient and average holding size as controls.

The Gini is negatively related with wheat output per hectare, and is significant at the 5% level. The point estimate indicates a very strong correlation of land inequality and wheat productivity, with a one standard deviation decrease in the Gini coefficient toward the more unimodal plough land distribution associated with an increase in wheat output per hectare of 13%. Column (2) adds controls for land in use and the most obvious result is that the point estimate for the Gini coefficient remains negative, with increased significance. This result is altered in column (3) when the capital per person-workman is added as control input variable. Now the Gini coefficient drops out as insignificant (and positive) , the size of family holdings predict that 1% increase of the average farm will influence on decrease of wheat productivity by about 0.82% significantly. The elasticity of wheat output value with respect to capital and labor because of half-intensive form (in column 3) and constant returns to scale set-up restriction is fitted as 0.52, and 0.48, respectively., the Gini and family holding size coefficients both have inverse effects on wheat productivity and are significant as determinants.

The Distribution of TFP in Wheat Production among Counties

The intensive form of Cobb–Douglas production function, (in column 4) estimation, provides a good fit to Croatia wheat output and is also a good analytical tool for TFP contribution accounting. The subject under discussion is the function $Y = AL^{0,29}K^{0,71}$. However, despite the statistical and econometrical acceptability it looks like that the coefficient βx=0.71 is in our judgment certainly overestimated beside if we assume that its size contain a unobservable fraction of the human capital involved in managing with the required tractors, combines, fertilizers etc. If we add various control variables (as the Gini coefficient elasticity par because afore-mentioned theory link: -output, the TFP, plough land distribution, and inputs,…, or land size or both determinants, but than alas operating with less degree of freedom in processing regression we obtained more acceptable ratio of capital – labor share in production value unit of wheat per ha. By virtue of be consistent with exposed theory we choose capital:labour elasticity ratio 0.6 : 0.4. This ratio is obtained according to column (6) where the Gini is involved as controlled variable (in the benchmark C/D model).

According to this, for the analyses of the distribution of the TFP, two artificially constructed functions will be used, which, satisfies the condition of constant returns to scale.

$$\ln(Ai) = \ln(yi) - ((0.71 * \ln(ki) + 0.29 * \ln(li))$$

$$\ln(Ai) = \ln(yi) - ((0.6 * \ln(ki) + 0.4 * \ln(li) + 2.1 * gi))$$

In Table 2 we try to depicted quantitatively the distributional effects of TFP differences across counties in wheat value output per ha. Because the impact of TFP on the wheat economy hinges on the parametrization of the plough land distribution too, our approach was to restrict these parameters using the cross-sectional heterogeneity within a county. Our results indicate that factor differences in TFP of 70 (even 74 by the Gini involved in) is related among Grad Zagreb county (as a rural producer are the weakest user of TFP in wheat production) and Dubrovačko –Neretvanska (as the strongest county in TFP implementation). Our explanation of such evidence implies that TFP differences across two counties are because Grad Zagreb is not traditionally rural area and the cumulative effects of "learning by doing" in the history of wheat production are very poor in Zagreb area. In other words, differences in TFP accumulation obtained according to Table 2 is substantial; whether plough-land inequality increases or decreases cross-section distribution of TFP across counties is a quantitative question and we can answer on that if we compare column 4 and in Table . We find that counties with lower TFP (as Grad Zagreb, Međimurska, Istarska) feature substantially more cross-section equality (or unimodel land distribution structure).

Conclusion

Our results show that the Gini coefficient and the diversity of wheat productivity degree across the counties are in a significant negative relationship. This effect persists even after controlling for, first by only land in use as a proxy for family holding size, and second for inputs use as a the capital –labor ratio. These results support our hypothesis on the advantages of unimodal or broad-based distributions of plough land in the oligopolistic structure of wheat production within Croatia. Yet if Croatia is country with relatively egalitarian structure of plough land distribution, as we find in this article, our point estimates imply that a drop in the Gini coefficient of one standard deviation would increase wheat output per hectare by 13 %. The elasticity of wheat output value with respect to capital and labor because of half-intensive form and constant returns to scale set-up restriction is fitted as 0.52, and 0.48, respect, or 0.7 and 0.3 in the pure intensive form. At the end we find that counties with lower TFP (as Grad Zagreb, Međimurska, Istarska), as a paradox, feature substantially more cross-section equality (or unimodel land distribution structure) and this result is in the first view contradictory with previous evidence but TFP as unobservable input in production could be endogenously linked with a specific climate or land quality factor, and in this paper we didn't modeled those issues.

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Appendix

Figure 1: Wheat output and plough land distribution

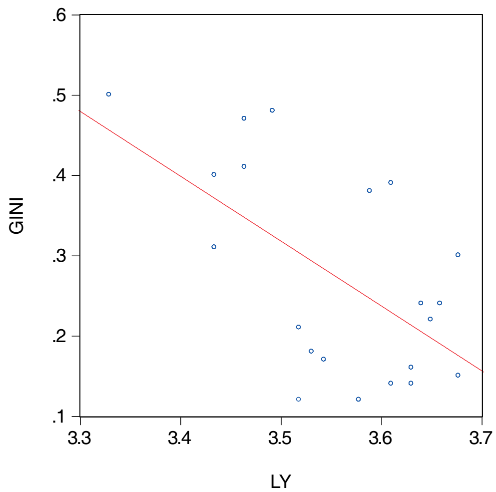

Figure 2: Plough land distribution and average holding size

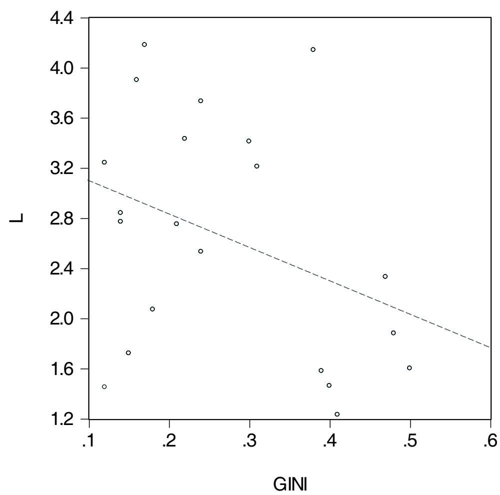

Table 1: OLS Regression Results

	DEP VARIABLE: LOG WHEAT OUTPUT PER HECTARE (IN EURO)			DEP VARIABLE: LOG WHEAT OUTPUT PER HECTARE (IN EURO) – LOG LABOUR FORCE		
Exp Variables	(1)	(2)	(3)	(4)	(5)	(6)
Gini Coefficient - Gi	-0.44** (-3.21)	-0.35** (-2.49)	-2.08* (-2.88)	-2.08* (-2.88)		-2.1** (-2.57)
Log Avg. Farm Size - ln Zi		0.15** (1.44)	-1.37** (-2.77)	-1.37** (-2.77)		
Log((No.Of Combines+tractors)-labour force))			0.51* (10.45)	0.51* (10.56)	0.7* (30.5)	0.6* (14.6)
Constant	3.67* (90.8)	3.59* (51.8)				
R- squared	0.35	0.41	0.54	0.55	0.11	0.34
Durbin-Watson		1.95	1.4	1.3	1.36	1.23

Table 2: The Total factor productivity in Wheat Production

County	TFP	TFP_GINI	TFP in percentage	TFP_GINI in percentage
Zagrebačka	0,04	2,16	0,18	1,66
Krapinsko-zagorska	0,64	3,76	3,05	2,89
Sisačko-moslavačka	0,58	3,40	2,75	2,62
Karlovačka	0,92	4,68	4,38	3,60
Varaždinska	0,54	3,49	2,58	2,69
Koprivničko-križevačka	0,45	3,10	2,14	2,39
Bjelovarsko-bilogorska	0,46	3,07	2,19	2,36
Primorsko-goranska	2,05	12,55	9,80	9,67
Ličko-senjska	1,72	9,74	8,21	7,51
Virovitičko-podravska	1,00	5,03	4,76	3,88
Požeško-slavonska	0,80	4,12	3,82	3,17
Brodsko-posavska	0,65	3,74	3,12	2,88
Zadarska	1,59	8,84	7,59	6,81
Osječko-baranjska	0,68	4,01	3,26	3,09
Šibensko-kninska	1,74	9,82	8,29	7,57
Vukovarsko-srijemska	1,30	6,90	6,22	5,32
Splitsko-dalmatinska	1,04	5,42	4,95	4,18
Istarska	0,52	3,48	2,47	2,68

Dubrovačko-neretvanska	2,80	24,82	13,37	19,12
Međimurska	0,59	3,48	2,81	2,68
Grad Zagreb	0,86	4,20	4,10	3,23
TOTAL			100,00	100,00